

ANNUAL REPORT AIR QUALITY IN ONTARIO 1984

STANDARDS DEVELOPMENT BRANCH OMSE



36936000003974

**TD
883.7
.06
A56
1986
MOE**

AIR QUALITY ASSESSMENT UNIT
AIR RESOURCES BRANCH



Ministry
of the
Environment
Ontario

Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact Service Ontario Publications at copyright@ontario.ca

DATE DUE

TD
883.7
.06
A56
1986

6194

TD
883.7C36
057
1984

ANNUAL REPORT — AIR QUALITY IN ONTARIO — 1984

... being a review of the Ministry of the Environment air quality monitoring program for 1984.

TABLE OF CONTENTS

INTRODUCTION	2
SECTION A — POLLUTANTS MEASURED BY CONTINUOUS MONITORING (HOURLY DATA)	3
1. SULPHUR DIOXIDE (SO ₂)	3
2. SOILING INDEX (COH)	3
3. TOTAL REDUCED SULPHUR (TRS)	4
4. CARBON MONOXIDE (CO)	4
5. HYDROCARBONS (THC/RHC)	4
6. NITROGEN DIOXIDE (NO ₂)	5
7. NITRIC OXIDE (NO)	5
8. TOTAL NITROGEN OXIDES (NO _x)	5
9. OZONE (O ₃)	5
SECTION B — THE ONTARIO AIR POLLUTION INDEX	7
10. AIR POLLUTION INDEX (API)	7
SECTION C — POLLUTANTS MEASURED BY HIGH VOLUME SAMPLER (DAILY DATA)	10
11. TOTAL SUSPENDED PARTICULATES (TSP)	10
12. LEAD (Pb)	10
13. TRACE METALS (Cadmium, Cobalt, Chromium, Copper, Iron, Manganese, Nickel, Vanadium, Zinc)	11
14. NITRATE (NO ₃ ⁻)	11
15. SULPHATE (SO ₄ ²⁻)	12
TABLES	
1. HIGHLIGHTS OF CONTINUOUS MONITORING (1984)	6
2. HISTORY OF THE AIR POLLUTION INDEX (1970 – 1984)	7
3. HIGHLIGHTS OF PARTICULATE MONITORING (1984)	12

INTRODUCTION

This report describes the 1984 Ontario air quality monitoring program including a summary of the measurements of gases and particulate matter during the year. It is intended for use in conjunction with an Appendix which appears in a separate volume.

For each pollutant, the following are discussed: characteristics of pollutant, effects, Ontario criteria (if any), sources, method of monitoring, locations (and frequency) of sampling, and summary of sampling results.

For each pollutant, tables provide the location of stations and supply sample distribution information including means, maxima and the number of exceedances of the Ontario criteria.

The entire continuous (hourly) network is summarized in Appendix Table A-1. This table gives station name, numerical identifier, and pollutants measured. Letter codes indicate whether data are telemetered or chart-read. The column headings for pollutants are as follows:

SO ₂	sulphur dioxide
COH	soiling index (coefficient of haze)
CO	carbon monoxide
O ₃	ozone
NO ₂	nitrogen dioxide
NO	nitric oxide
NOx	total nitrogen oxides
THC	total hydrocarbons
RHC	reactive (non-methane) hydrocarbons
TRS	total reduced sulphur
API	air pollution index
WS1	wind speed — level 1
WD1	wind direction — level 1
WS2	wind speed — level 2
WD2	wind direction — level 2
WS3	wind speed — level 3
WD3	wind direction — level 3
TEM	temperature — level 1
DT1	temperature difference (level 2 – level 1)
DT2	temperature difference (level 3 – level 1)

Section A of this report describes each of the gaseous pollutants in sequence. Section B deals with the Air Pollution Index.

The particulate (daily) network is summarized in Appendix Table A-2. This table gives station name, numerical identifier, and pollutants measured. Numerals indicate the monitoring cycle frequency in days. Some additional codes are defined in the key at the top of the table. The column headings for pollutants are as follows:

TSP	total suspended particulate
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cu	Copper
Fe	Iron
Mn	Manganese
Ni	Nickel
PbA	Lead (analysed by Atomic Absorption)
PbX	Lead (analysed by X-Ray Spectroscopy)
V	Vanadium
NO ₃	Nitrate
SO ₄	Sulphate

Section C describes each of these particulate pollutants under the headings of TSP, Lead, Trace Metals, Nitrate and Sulphate.

Queries relating to this report or requests for data (magnetic tape or hardcopy) should be addressed to:

Joel Kurtz or Phil Kiely
Air Quality Assessment Unit
Air Resources Branch
125 Resources Road
Rexdale, Ontario
M9W 5L1

Telephone (416) 248-3245

GLOSSARY

criterion — a recommended maximum ambient air exposure (based on effects)

detection limit — the minimum air concentration of a pollutant that can be determined by an analytical method

geometric mean — calculated by taking the nth root of the product of all (n) values in a data set
— provides a better indication than arithmetic mean of central tendency for a small data set with extreme values

percentile value — the percentage of the data set that lies below the stated value

— for example, if the 70 percentile value is 0.10 ppm, then 70% of the data are below 0.10 ppm

primary pollutant — a pollutant which is directly emitted to the atmosphere

secondary pollutant — a pollutant which is formed from other pollutants present in the atmosphere

ABBREVIATIONS

ppb — parts (of pollutant) per billion (parts of air)

ppm — parts (of pollutant) per million (parts of air)

ug/m³ — micrograms (of pollutant) per cubic metre (of air)

SECTION A POLLUTANTS MEASURED BY CONTINUOUS MONITORING (HOURLY DATA)

SO₂

SULPHUR DIOXIDE

1.1 Characteristics

Colourless gas. Strong, pungent odour over 0.5 ppm.

1.2 Effects

1 hour average

less than .16 ppm	— no known effects
.25 ppm	— injurious to sensitive species of vegetation
.34 ppm	— odorous, increasing vegetation damage
greater than 2.00 ppm	— increasing sensitivity of asthmatics and bronchitics

1.3 Ontario Criteria

.25 ppm (1 hour)
.10 ppm (24 hours)
.02 ppm (1 year)

Limiting effect — Health, vegetation.

1.4 Sources

80% of the SO₂ emitted in Ontario originates from non-ferrous smelters and electric utilities.

The rest comes from industrial sources including iron ore smelters, petroleum refineries, pulp and paper mills and area sources including vehicles and residential, commercial and industrial heating.

1.5 Method of Monitoring

Fluorescent excitation of SO₂ by pulsed ultra-violet radiation.

1.6 Locations of Monitoring

The Appendix provides a description of the provincial SO₂ network (Table A-1).

SO₂ monitoring was carried out at 88 locations in 1984.

1.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Table A-3). Also given are the number of exceedances of the sulphur dioxide criteria (see Section 1.3).

The lowest levels measured in the province were Thunder Bay Hospital where the hourly SO₂ never exceeded .02 ppm.

The greatest number of exceedances of the one hour criterion occurred at Balmertown (sewage treatment plant) and the highest annual mean was measured at Hamilton (North Park).

There were a total of 20 stations which exceeded the hourly criterion at least once and six which exceeded the 24 hour criterion. No station exceeded the annual criterion. (See also Table 1).

2.4 Sources

Industrial processes which include combustion, incineration, construction, mining, metal smelting and processing, grinding.

Natural sources include wind-blown soil, forest fires, ocean spray, volcanic activity.

2.5 Method of Monitoring

Continuous paper tape sampler with sampling inlet and flow rate regulated to favour small particles.

COH is determined by drawing a known volume of air through a portion of tape and then measuring the reduction in the light transmitted relative to a clean section of tape.

2.6 Locations of Monitoring

The Appendix provides a description of the provincial COH network (Table A-1).

Soiling Index was measured at 41 locations in 1984.

2.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; the maximum one hour and 24 hour values; and the number of exceedances of the COH criteria (see Section 2.3) are provided in the Appendix (Table A-4).

The lowest levels measured in the province were at Coniston (backup) in the Sudbury Basin where the COH averaged 0.13 units.

The greatest number of exceedances of the 24 hour criterion occurred at Hamilton (North Park) and the highest annual mean was at North Park as well.

There were a total of 24 stations which exceeded the 24 hour criterion at least once and five which exceeded the one year criterion. (See also Table 1).

COH

SOILING INDEX

2.1 Characteristics

A relative measure of suspended particulate matter of size most likely to reach the lungs (diameter less than 5–10 microns). Determined by the amount of soiling caused by air flow on a filter medium.

2.2 Effects

1 hour average

less than 2.0 COH units	— no known effects
2.0 COH units	— decrease in visibility
4.0 COH units	— soiling evident
6.0 COH units	— increasing sensitivity of asthmatics and bronchitics

2.3 Ontario Criteria

1.0 COH units/1000 feet (24 hours)
0.5 COH units/1000 feet (1 year)

Limiting effect — Health.

TRS

TOTAL REDUCED SULPHUR

3.1 Characteristics

Primarily hydrogen sulfide (rotten egg odour). Also methyl mercaptans (rotten cabbage odour over 5 ppb).

3.2 Effects

1 hour average

less than 10 ppb	— no known effects
10 ppb	— odour threshold
27 ppb	— extremely odorous
1,000 ppb	— sensitive individuals may suffer nausea and headache due to severe odour

3.3 Ontario Criteria

Hydrogen Sulfide — 27 ppb (1 hour) (provisional guideline)

Methyl mercaptans — 10 ppb (1 hour).

Limiting Effect — Odour

3.4 Sources

Industrial — pulp and paper mills, refineries. Natural — swamps, bogs, marshes.

3.5 Method of Monitoring

Reduced sulphur compounds are oxidized to SO₂ followed by fluorescent excitation by ultra-violet radiation.

3.6 Locations of Monitoring

The Appendix provides a description of the provincial TRS network (Table A-1).

TRS monitoring was carried out at 31 locations in 1984.

3.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the one hour and 24 hour maxima are provided in the Appendix (Table A-5).

The lowest levels measured in the province were at Science North in Sudbury. The highest annual mean occurred at Boise Cascade in Fort Frances. The greatest value measured was 254 ppb at Thorold.

All stations monitoring the pulp and paper industry exceeded the Ontario criterion (provisional guideline of H₂S for the pulp and paper industry) of 27 ppb. (See also Table 1).

CO

CARBON MONOXIDE

4.1 Characteristics

Colourless, odourless.

4.2 Effects

1 hour average

less than 30 ppm	— no known effects
30 ppm	— increased cardiovascular symptoms on smokers with heart disease
50 ppm	— increasing cardiovascular symptoms on non-smokers with heart disease. Some visual impairment

4.3 Ontario Criteria

30 ppm (1 hour)

13 ppm (8 hours)

Limiting effect — Health.

4.4 Sources

Primary source (about 80%) is motor vehicles. A secondary source is fossil fuel combustion for building, heating and commercial/industrial operations.

4.5 Method of Monitoring

Non-dispersive infra-red photometry based on the preferential absorption of infra-red radiation by CO.

4.6 Locations of Monitoring

The Appendix provides a description of the provincial CO network (Table A-1).

CO was monitored at 26 stations in 1984.

4.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and eight hour values are given in the Appendix (Table A-6).

The lowest levels measured in the province were at Centennial Park in Sarnia; the highest mean was at the Mission (381 Yonge Street) in Toronto. The highest measured one hour and eight hour values were also at the Mission.

No station monitored CO values above the Ontario one hour criterion of 30 ppm; however the Mission monitor registered values in excess of the eight hour criterion on 10 occasions. (See also Table 1).

THC/RHC

HYDROCARBONS

5.1 Characteristics

Primarily methane (colourless, odourless) which is present at about 1.5 ppm in the ambient atmosphere. Non-methane hydrocarbons (or reactive hydrocarbons) are usually present at much lower levels. This fraction reacts with nitrogen oxides in the presence of sunlight to form ozone.

5.2 Effects

No known effects at ambient levels.

5.3 Ontario Criteria

None.

5.4 Source

Natural sources include trees and other vegetation and decay of animal and plant material.

Anthropogenic sources include motor vehicles, gasoline storage tanks, petroleum and chemical industries.

5.5 Method of Monitoring

Calibrated flame ionization detector.

5.6 Locations of Monitoring

The Appendix provides a description of the provincial THC/RHC network (Table A-1).

Hydrocarbon monitoring (total or reactive) was carried out at 18 locations in 1984.

5.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are given in the Appendix (Tables A-7 and A-8).

The locations and values for the lowest, and highest means are given in Table 1. Hamilton (Barton/Wentworth) measured the highest maximum concentration of reactive hydrocarbon for the year.

The highest total hydrocarbon value for the year was measured at the Science Centre in North York.

NO₂

NITROGEN DIOXIDE

6.1 Characteristics

Brown gas. Pungent, irritating odour over .12 ppm.

Oxidation product of nitric oxide (NO) which is the primary NO_x emission. Reacts with hydrocarbons in sunlight to form ozone; and with water to form nitric acid, a component of acid rain.

6.2 Effects

1 hour average

less than .10 ppm	— no known effects
.10 ppm	— odour threshold
.25 ppm	— some increase in bronchial reactivity in asthmatics
.52 ppm	— increasing sensitivity of asthmatics and bronchitics

6.3 Ontario Criteria

.20 ppm (1 hour)

.10 ppm (24 hours)

Limiting effect — Health.

6.4 Sources

Anthropogenic — high temperature combustion processes including automobiles, power plants, incinerators and several chemical processes. In Ontario, transportation accounts for about 60% of total NO_x emissions.

Natural — lightning, soil bacteria.

6.5 Method of Monitoring

Based on the principle of chemiluminescence involving a gas phase reaction of NO with ozone. For NO₂ the sample stream is passed through a catalytic converter where NO₂ is reduced to NO.

6.6 Locations of Monitoring

The Appendix provides a description of the provincial NO₂ network (Table A-1).

NO₂ monitoring was carried out at 33 locations in 1984.

6.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Table A-9). Also given are the number of exceedances of the nitrogen dioxide criteria (see Section 6.3).

The lowest levels measured in the province were at Hawkeye Lake where the arithmetic mean was .000 ppm.

The greatest number of exceedances of the one hour criterion occurred at Sudbury (Ash Street) and the highest annual mean was measured at Toronto (Mission).

There were a total of two stations which exceeded the one hour criterion at least once, but no stations exceeded the 24 hour criterion. (See also Table 1)

NO_X

TOTAL NITROGEN OXIDES

8. NO_x is assumed to be the sum of NO₂ and NO concentrations in the atmosphere (in parts per million). Normally, this assumption is valid. (See Appendix Table A-11 for the data summaries).

O₃

OZONE

NO

NITRIC OXIDE

7.1 Characteristics

Colourless gas. Oxidizes to NO₂ in the presence of hydrocarbons and sunlight.

7.2 Effects

No known effects at ambient levels.

7.3 Ontario Criteria

None.

7.4 Sources

Same as for NO₂.

7.5 Method of Monitoring

Same as for NO₂.

7.6 Locations of Monitoring

Same as for NO₂.

7.7 Results of Monitoring

Long Point Provincial Park had the lowest mean; North York (Hwy. 401) the highest. (See Appendix Table A-10 for the data summaries).

9.1 Characteristics

Colourless gas. Major component of photochemical oxidant compounds formed as the result of chemical reactions between nitrogen oxides and reactive hydrocarbons in the presence of sunlight.

9.2 Effects

1 hour average

less than 50 ppb	— no known effects
80 ppb	— injurious to many species of vegetation
120 ppb	— decreasing performance by athletes exercising heavily
200 ppb	— decrease in lung function in exercising subjects, eye irritation

9.3 Ontario Criteria

80 ppb (1 hour)

9.4 Sources

Ozone is produced by photochemical reactions and not directly emitted into the atmosphere. Since it is formed downwind of nitrogen oxide and hydrocarbon sources and capable of travelling long distances through the atmosphere, ozone is a major manifestation of the long range transport of air pollution. Its formation and transport are dependent on meteorological factors.

9.5 Method of Monitoring

An air sample reacts with ethylene to emit visible light (chemiluminescence) of intensity directly proportional to the ozone concentration.

9.6 Locations of Monitoring

The Appendix provides a description of the provincial O₃ network (Table A-1).

Ozone monitoring was carried out at 36 locations in 1984.

9.7 Monitoring Results

The distribution by percentile of the hourly data; the mean; and the maximum one hour and 24 hour values are provided in the Appendix (Table A-12). Also given are the number of exceedances of the ozone criterion (see Section 9.3).

The lowest levels measured in the province were at Peterboro (City Hall) where the arithmetic mean was 10.9 ppb.

The greatest number of exceedances of the one hour criterion occurred at Long Point Provincial Park which also recorded the highest mean concentration for the year.

There were a total of 31 stations which exceeded the criterion at least once. The highest measured concentration was 162 ppb at Burlington. (See also Table 1).

TABLE 1
HIGHLIGHTS OF CONTINUOUS MONITORING — 1984

Pollutant (Units)	Lowest Mean	Highest Mean	Most Criteria Exceedances		Number of Stations Exceeding Criteria			Highest Measured Value (one hour)	Total Number of stations
			1 hour	24 hour	1 hr.	24 hr.	1 Yr.		
SO ₂ (ppm)	63022 ¹ (.000) ²	29008 (.016)	61014 (50)	77201 (3)	20	6	0	77201 (0.99)	88
COH	77128 (0.13)	29008 (0.72)	n.a.	29008 (69)	n.a.	24	5	29025 (4.6)	41
TRS (ppb)	77203 (0.0)	62051 (5.2)	27052 (376)	n.a.	n.a.	n.a.	n.a.	27052 (254)	31
CO (ppm)	14064 (0.1)	31049 (3.6)	—(0)	n.a.	0	n.a.	n.a.	31049 (29)	26
RHC(ppm)	27037 (0.14)	12008 (0.40)	n.a.	n.a.	n.a.	n.a.	n.a.	29025 (5.9)	8
THC (ppm)	31104 (1.89)	15001 (2.89)	n.a.	n.a.	n.a.	n.a.	n.a.	34002 (18.7)	11
NO ₂ (ppm)	63100 (.000)	31049 (.040)	77016 (3)	—(0)	2	0	n.a.	77016 (0.43)	33
NO _x (ppm)	63100 (.003)	34007 (.129)	n.a.	n.a.	n.a.	n.a.	n.a.	31049 (1.03)	33
NO (ppm)	22901 (.001)	34007 (.092)	n.a.	n.a.	n.a.	n.a.	n.a.	31049 (0.94)	33
O ₃ (ppb)	59006 (10.9)	22901 (29.7)	22901 (152)	n.a.	31	n.a.	n.a.	44008 (162)	36

¹Station Number (for location see Appendix Table A-1)

²(Value)

SECTION B

THE ONTARIO AIR POLLUTION INDEX (API)

10.1 Characteristics

The API is the basis of an alert system to warn of deteriorating air quality and is derived from 24 hour running averages of sulphur dioxide and soiling index. Research studies have linked respiratory illness to high concentrations of sulphur dioxide and particulates.

10.2 Legislation

The Ontario Environmental Protection Act (1971) authorizes the Minister of the Environment to order any source not essential to public health or safety to curtail or cease its operations when air pollution levels which may be injurious to health occur.

10.3 Operation of the System

The API is computed each hour based on the past 24 hourly values for SO_2 and COH. If the index reaches a value of 32 (as for example when $\text{SO}_2 = 0.1 \text{ ppm}$ and $\text{COH} = 1.0$) and if the Duty Meteorologist predicts a continuation of adverse atmospheric conditions for at least six hours, an Air Pollution Advisory is issued. Owners of significant sources of pollution are advised to prepare for possible curtailment of operations.

If the index reaches 50, and if at least six hours of adverse atmospheric conditions are forecast, owners of major sources will be ordered to curtail operations. This is the First Alert Level.

A Second Alert is issued at an API of 75, and further curtailment may be ordered.

The Air Pollution Episode Threshold Level occurs at an API of 100. If atmospheric conditions are not expected to improve for at least six hours, owners of all sources not essential to public health or safety will be ordered to cease operations.

10.4 Air Pollution Index Levels (1970 – 1984)

A history of the Air Pollution Index over the 15 years of its operation is provided in Table 2.

TABLE 2
ONTARIO'S AIR POLLUTION INDEX

Date Started:	TORONTO	Mar. 23, 1970			
	HAMILTON	June 15, 1970			
	SUDSBURY	Jan. 16, 1971			
	WINDSOR	Mar. 19, 1971			
	HAPPY VALLEY	May 13, 1971		(Closed Jan./75)	
	WELLAND	Jan. 1, 1974		(Closed Oct./78)	
	NIAGARA FALLS	Nov. 1, 1974			
	CONISTON	Feb. 18, 1975			
	NEW SUDSBURY	Mar. 1, 1976			
	SARNIA	Dec. 1, 1977			
	ST. CATHARINES	Sep. 14, 1979			

YEAR	CITY	NUMBER OCCASIONS		MAXIMUM INDEX	DATE OF MAXIMUM
		≥ 32	≥ 50		
1970	TORONTO	17	2	56	Oct. 8
	HAMILTON	2	1	56	Oct. 8
	1971	TORONTO	19	1	52
		HAMILTON	23	0	48
		SUDSBURY	26	3	87
		WINDSOR	2	0	33
		HAPPY VALLEY	20	7	64
	1972	TORONTO	2	0	45
		HAMILTON	6	0	41
		SUDSBURY	7	1	79
		WINDSOR	9	1	53
		HAPPY VALLEY	20	11	139
1973	TORONTO	3	0	43	Oct. 24
	HAMILTON	2	0	34	Feb. 14
	SUDSBURY	0	0	26	Mar. 14
	WINDSOR	7	0	44	Feb. 19
	HAPPY VALLEY	19	10	94	Aug. 21
1974	TORONTO	3	1	50	Oct. 29
	HAMILTON	11	0	44	Oct. 29
	SUDSBURY	1	0	32	Jul. 13
	WINDSOR	2	0	41	Jan. 7
	HAPPY VALLEY	24	13	116	Apr. 23
	WELLAND	46	15	77	Oct. 6
	NIAGARA FALLS	0	0	20	Nov. 9
1975	TORONTO	2	1	62	Nov. 20
	HAMILTON	10	0	38	Oct. 24
	SUDSBURY	0	0	30	Feb. 1
	WINDSOR	0	0	28	Feb. 11
	WELLAND	0	0	23	Jan. 24
	NIAGARA FALLS	0	0	21	Nov. 24
	CONISTON	0	0	30	May 13

ONTARIO'S AIR POLLUTION INDEX

YEAR	CITY	NUMBER	MAXIMUM	DATE OF MAXIMUM
		≥ 32	≥ 50	
1976	TORONTO	1	0	33 Oct. 3
	HAMILTON	8	0	41 Dec. 16
	SUDBURY	0	0	28 June 6
	WINDSOR	1	0	34 Dec. 16
	WELLAND	0	0	24 Dec. 16
	NIAGARA FALLS	0	0	25 Feb. 21
	CONISTON	0	0	29 Sep. 16
	NEW SUDBURY	0	0	29 Apr. 2, 3
				June 20
1977	TORONTO	4	0	36 Jan. 15
	HAMILTON	10	0	44 Mar. 12
	SUDBURY	0	0	24 June 11
	WINDSOR (12008)	1	0	33 Apr. 19
	WINDSOR (12016)	0	0	29 Apr. 19
	WELLAND	0	0	22 Jan. 24, 25
	NIAGARA FALLS	0	0	28 Feb. 21
	CONISTON	0	0	25 Apr. 25
	NEW SUDBURY	1	0	39 June 11
1978	SARNIA	0	0	15 Dec. 13
	TORONTO	2	0	45 Nov. 5
	HAMILTON	7	0	43 Nov. 4
	SUDBURY	0	0	31 Jan. 22
	WINDSOR (12008)	1	0	33 Apr. 19
	WINDSOR (12016)	0	0	28 Feb. 18
	WELLAND	0	0	24 Mar. 15
	NIAGARA FALLS	0	0	23 Nov. 4
				Mar. 11
1979	CONISTON	3	0	34 Feb. 7
	NEW SUDBURY	1	0	42 Feb. 2
	SARNIA	3	0	41 Jan. 24
	TORONTO	2	0	35 Oct. 18
	HAMILTON	23	1	55 Dec. 22
	SUDBURY	0	0	18 July 7
	WINDSOR (12008)	0	0	31 Feb. 20
	WINDSOR (12016)	0	0	27 Feb. 21
	NIAGARA FALLS	0	0	27 Feb. 21
1980	CONISTON	0	0	31 Feb. 14
	NEW SUDBURY	0	0	28 Feb. 14
	SARNIA	2	0	43 Feb. 20
	ST. CATHARINES	0	0	29 Nov. 6
	TORONTO	0	0	31 Dec. 8
	HAMILTON	5	0	40 Oct. 16
	SUDBURY	0	0	23 Oct. 16
	WINDSOR (12008)	0	0	25 Feb. 8, 9
	WINDSOR (12016)	0	0	25 Dec. 29
1981	NIAGARA FALLS	0	0	18 May 24
	CONISTON	0	0	30 Feb. 10, Mar. 9
	NEW SUDBURY	0	0	24 Jul. 3, Oct. 16
	SARNIA	1	0	39 Mar. 20
1982	ST. CATHARINES	0	0	28 Feb. 20

ONTARIO'S AIR POLLUTION INDEX

YEAR	CITY	NUMBER OCCASIONS		MAXIMUM INDEX	DATE OF MAXIMUM
		≥ 32	≥ 50		
1981	TORONTO	3	0	43	Nov. 14
	HAMILTON	8	0	38	Nov. 15
	SUDBURY	0	0	21	Jan. 31
	WINDSOR (12008)	1	0	42	Nov. 17
	WINDSOR (12016)	0	0	31	Nov. 17
	NIAGARA FALLS	0	0	25	Jan. 14
	CONISTON	0	0	20	Nov. 25
	NEW SUDBURY	0	0	22	Jan. 28 – 29
	SARNIA	1	0	34	Feb. 16
	ST. CATHARINES	0	0	27	Jan. 14 – 15
1982	TORONTO	3	2	54	Oct. 27
	HAMILTON	12	0	39	Dec. 2
	SUDBURY	0	0	15	Feb. 3
	WINDSOR (12008)	0	0	31	Oct. 26 – 27
	WINDSOR (12016)	1	0	35	Oct. 27
	NIAGARA FALLS	0	0	19	Jan. 19
	CONISTON	1	0	39	Feb. 5
	NEW SUDBURY	0	0	29	Feb. 5
	SARNIA	0	0	27	Mar. 11
	ST. CATHARINES	0	0	31	Nov. 7 – 8
1983	TORONTO	3	0	39	Jan. 29
	HAMILTON	1	0	37	Mar. 2
	SUDBURY	1	0	39	Jan. 22
	WINDSOR (12008)	0	0	26	Sep. 27
	WINDSOR (12016)	1	0	33	Mar. 1 – 2
	NIAGARA FALLS	0	0	17	Jan. 30
	CONISTON	0	0	19	Jan. 15
	NEW SUDBURY	1	1	63	Jan. 22
	SARNIA	0	0	28	Jan. 29
	ST. CATHARINES	0	0	23	Jan. 30
1984	TORONTO	2	1	50	Jan. 16
	HAMILTON	8	0	44	Nov. 27
	SUDBURY	0	0	23	Feb. 1
	WINDSOR (12008)	0	0	31	Oct. 2, Nov. 14
	WINDSOR (12016)	1	0	40	Feb. 15
	NIAGARA FALLS	0	0	20	Dec. 10 – 11
	CONISTON	0	0	29	Nov. 22
	NEW SUDBURY	0	0	23	Nov. 22
	SARNIA	0	0	27	Jan. 23
	ST. CATHARINES	0	0	24	Feb. 10 – 11

SECTION C POLLUTANTS MEASURED BY HIGH VOLUME SAMPLER MONITORING (DAILY DATA)

TSP

TOTAL SUSPENDED PARTICULATE

11.1 Characteristics

Suspended particulate is a generic term for airborne particles including smoke, fume, dust, fly ash and pollen. Composition varies with place and season but normally includes soil particulates, organic matter, sulphur and nitrogen compounds and metals such as lead. Size range is approximately .1 to 100 microns (10^{-6} metres diameter).

11.2 Effects

The greatest impact on health is from particles less than 10 microns in diameter which can penetrate deep into the lungs and contribute to respiratory disease. More serious health effects may be associated with suspended particulate matter which contains a toxic particulate component or which has adsorbed a gaseous pollutant on the surface of the particles. Corrosion, soiling, damage to vegetation and visibility reduction are additional effects.

11.3 Ontario Criteria

120 ug/m³ (24 hours)
60 ug/m³ (1 year — geometric mean)

Limiting Effect — Health

11.4 Sources

Natural sources include wind-blown soil, forest fires and plant pollen. Anthropogenic sources include combustion, incineration, construction, mining, metals smelting and processing, grinding processes, agricultural activity and transportation.

11.5 Method of Monitoring

By High Volume Sampler. Air is drawn through a filter at the rate of approximately 1.4 m³/min. The (daily) mass concentration of total suspended particulate matter is computed from the mass of collected particles and the volume of air sampled.

11.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-2).

TSP was measured at 147 locations in 1984.

11.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (table A-13). Also, given are the number of exceedances of the 24 hour and one year criteria.

The lowest levels measured in the province were at Atikokan (weather station) where TSP never exceeded 28 ug/m³.

The greatest number of exceedances of the 24 hour criterion occurred at Hamilton (North Park) and the highest annual mean was measured at Thorold.

There were a total of 122 stations which exceeded the 24 hour criterion and 32 which exceeded the one year criterion. (See also Table 3).

Pb

LEAD IN SUSPENDED PARTICULATE

12.1 Characteristics

A silver bluish, white, soft metal.
Molecular weight 207.20.

12.2 Effects

Can degrade renal function, impair hemoglobin synthesis, and alter the nervous system.

12.3 Ontario Criteria

5.0 ug/m³ (24 hours)
2 ug/m³ (30 day-geometric mean)

Limiting Effect — Health

12.4. Sources

Combustion of gasoline containing lead additives, secondary smelting of lead, battery manufacture, metal fabrication, some paint and glass manufacture, production of iron, steel, copper and nickel.

Lead emissions fell significantly after 1975 with the introduction of lead-free gasoline.

12.5 Method of Monitoring

Lead concentration on high volume filters determined by either X-Ray fluorescence (PbX) or atomic absorption (PbA).

12.6 Location and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-2).

Lead was measured at 78 locations in 1984.

12.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic and geometric means are given in the Appendix (Table A-14). Also given are the number of exceedances of the 24 hour criterion. Note that the lowest value reported in these tables is 1 (see Section 13.7 for a discussion of the minimum values).

The lowest lead levels in the province occurred at several rural locations including Mooretown and Simcoe.

The greatest number of exceedances of the 24 hour criterion occurred at Mississauga (2414 Dixie Road) in the vicinity of a lead processing plant. The highest annual mean was at this location as well.

There were a total of six stations which exceeded the daily criterion at least once. (See also Table 3).

TRACE METALS

CADMIUM, COBALT,
CHROMIUM, COPPER,
IRON, MANGANESE,
NICKEL, VANADIUM, ZINC

13.1 Characteristics

Name	Symbol	Properties	Molecular Weight
Cadmium	Cd	silver white, hexagonal	112.41
Cobalt	Co	silver grey, cubic	58.93
Chromium	Cr	steel grey, cubic	52.00
Copper	Cu	red, cubic	63.55
Iron	Fe	silver, cubic	58.85
Manganese	Mn	grey-pink, cubic	54.94
Nickel	Ni	silver, cubic	58.69
Vanadium	V	light grey, cubic	50.94
Zinc	Zn	bluish-white, hexagonal	65.38

13.2 Effects

Depth of penetration into the respiratory system (and consequently risk to health) increase as particle size diminishes. Of the heavy metals, cadmium, chromium and vanadium probably pose the greatest risk to human health and this is reflected in the Ontario criteria (see Section 13.3).

13.3 Ontario Criteria

	24-hour Criterion	Limiting Effects
Cadmium	2 ($\mu\text{g}/\text{m}^3$)	Health
Chromium	1.5 ($\mu\text{g}/\text{m}^3$)	Health
Copper	50 ($\mu\text{g}/\text{m}^3$)	Health
Manganese	50 ($\mu\text{g}/\text{m}^3$)	Health
Nickel	2 ($\mu\text{g}/\text{m}^3$)	Vegetation
Vanadium	2 ($\mu\text{g}/\text{m}^3$)	Health
Zinc	100 ($\mu\text{g}/\text{m}^3$)	Health

13.4 Sources

See Section 1.4.

13.5 Method of Monitoring

Collection is by High Volume Sampler (see Section 11.5). Following determination of TSP, a strip is cut from the exposed filter and ashed to destroy carbonaceous matter. The ashed sample is then digested in acid, and analyzed by atomic absorption spectrophotometry. The mass concentration of each metal in

ambient air is calculated from the mass of each metal in TSP and the volume of air sampled, and expressed in $\mu\text{g}/\text{m}^3$.

Detection limits of the analytical methods are listed below.

Metal	Detection Limit ($\mu\text{g}/\text{m}^3$)
Cd	.002
Co	.011
Cr	.004
Cu	.004
Fe	.210
Mn	.007
Ni	.004
V	.014
Zn	.210

13.6 Locations and Frequency of Sampling

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-2).

Metals were measured at 55 to 60 stations depending on the element.

13.7 Monitoring Results

The distribution by percentile of the daily data; the maximum; the arithmetic mean; the geometric mean; and the number of exceedances of the daily criterion are provided in the Appendix (Tables A-15 to A-21 for Cadmium through Vanadium respectively). No table is provided for Cobalt where 99.9% of the measurements were below detection limits. Also, the analysis for Zinc has been discontinued due to contamination of the filters by the exhaust from the High Volume Sampler instrument.

There is a difficulty in reporting and performing calculations with data where a significant portion is below detection limits. For data prior to 1986, a value of one unit was reported whenever data fell below the detection limit. Thus in Table A-15 for Cadmium, for example, many of the percentile values are reported as 1 (i.e. .001 $\mu\text{g}/\text{m}^3$). Beginning with 1986 data, the system for reporting and calculating distribution statistics, which includes many values below detection limits, was improved.

Table 3 provides the highlights of Particulate Monitoring for 1984. It shows that only a single exceedance of the air quality criteria for a metal (exclusive of lead) occurred in 1984. This was at Port Colborne and the metal was nickel. Such an exceedance may be harmful to vegetation.

NO₃⁻

NITRATE

14.1 Characteristics

Nitrogen oxide compounds, formed from atmospheric nitrogen and oxygen through high temperature combustion, photochemical reactions or bacterial action, may react with other compounds in the air to form nitrate (NO₃⁻) or nitric acid (HNO₃).

14.2 Effects

Nitrate and nitric acid are involved in corrosion of materials, visibility degradation and acidic precipitation. They may also have an adverse effect on human health.

14.3 Ontario Criteria

None.

14.4 Sources

Nitrate is primarily a secondary pollutant. Anthropogenic sources of nitrogen oxides or nitrates include all high temperature combustion processes, transportation, and fertilizer production and usage. Natural sources include lightning, biological decomposition and photochemical reactions.

14.5 Method of Monitoring

Nitrates collected on glass fibre filters by a High Volume Sampler are extracted by digestion in distilled water. This extract is reduced to nitrite followed by colourimetric analysis for determination of the mass concentration of atmospheric nitrate.

14.6 Locations and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-2).

Nitrate monitoring was carried out at 69 locations in 1984.

14.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-22). Highlights of monitoring are summarized in Table 3.

The highest annual mean nitrate concentration was measured at Hamilton (North Park); the highest concentration for a single day occurred at North York (Hwy. 401).

SO_4^{2-}

SULPHATE

15.1 Characteristics

Sulphur dioxide is oxidized in the atmosphere to eventually form sulphate compounds. Intermediaries in the oxidation process such as HSO_3 and SO_3 rapidly combine with water vapour to form sulfuric acid aerosol. This type of process is dependent on atmospheric conditions.

15.2 Effects

Sulphate compounds have been linked to respiratory irritation and disease, corrosion of materials, reduction of visibility and the formation of acidic precipitation.

15.3 Ontario Criteria

None

15.4 Sources

Sulphate is primarily a secondary pollutant. Anthropogenic sources of sulphur oxides include the burning of fuels containing sulphur (such as coal and oil), the smelting of sulphur-containing metals and the refining of petroleum. Natural sources include bacterial decomposition, volcanoes and forest fires.

15.5 Method of Monitoring

Sulphate collected on glass fibre filters by a High Volume Sampler is extracted by digestion in distilled water. The extract is analyzed colourimetrically and the mass concentration of sulphate is calculated.

15.6. Locations and Frequency of Monitoring

The monitoring locations and the length of the sampling cycle (in days) for each location are indicated in the Appendix (Table A-2).

Sulphate monitoring was carried out at 69 locations in 1984.

15.7 Monitoring Results

The distribution by percentile; the maximum; the arithmetic mean; and the geometric mean are given in the Appendix (Table A-23). Highlights of monitoring are summarized in Table 3.

The highest annual mean sulphate concentration was measured at Hamilton (North Park); and the highest concentration for a single day occurred at Toronto (Sherbourne/Wilton).

TABLE 3
HIGHLIGHTS OF PARTICULATE MONITORING — 1984

Pollutant (Unit $\times \mu\text{g}/\text{m}^3$)	Lowest Mean	Highest Mean	Most Criteria Exceedances 24 Hours	Number of Stations Exceeding Criteria 24 Hour	Number of Stations Exceeding Criteria 1 Year	Highest Measured Value	Total Number of Stations	
TSP	62013 ¹	(28) ²	27052 (153)	29008 (100)	122	32	27052 (631)	147
Cd (.001)	63005	(<1)	35037 (20)	— (0)	0	n.a.	35037 (343)	57
Co (.01)	SEVERAL	(<1)	77026 (1)	n.a.	n.a.	n.a.	54013 (5)	57
Cr (.001)	46025	(<1)	29011 (25)	— (0)	0	n.a.	45060 (235)	55
Cu (.01)	12005	(2)	77070 (55)	— (0)	0	n.a.	15001 (306)	57
Fe (.01)	47042	(4)	71042 (85)	n.a.	n.a.	n.a.	71042 (394)	60
Mn (.001)	14030	(14)	71042 (543)	— (0)	0	n.a.	45060 (2920)	56
Ni (.001)	63005	(<1)	27047 (217)	27047 (1)	1	n.a.	27047 (2400)	59
Pb (0.1)	SEVERAL	(<1)	46041 (28)	46041 (55)	6	n.a.	31085 (313)	78
NO_3^- (0.1)	72077	(8)	29008 (64)	n.a.	n.a.	n.a.	34007 (333)	69
SO_4^{2-} (0.1)	63022	(44)	29008 (148)	n.a.	n.a.	n.a.	31105 (533)	69
V (.001)	45060	(<1)	29025 (10)	— (0)	0	n.a.	45011 (221)	57

¹Station Number (for locations see Appendix Table A-2).

²(Value)

**TD
883.7
.06
A56
1986**

Air quality in Ontario : annual
report 1984 /
15331

